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Time reference decoupled from tense in agrammatic and fluent aphasia

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A B S T R A C T

Background: Reference to an event's time frame can be accomplished through verb inflection. In agrammatic aphasia, a deficit in past time reference has been identified by Bastiaanse and colleagues (2011). In fluent aphasia, specific problems with this time frame (expressed by the past tense) have been found as well (Dragoy & Bastiaanse, 2013; Jonkers & de Bruin, 2009). However, time reference does not always coincide with tense; in languages such as Dutch and English, reference to the past can be established by using past tense (e.g., "he wrote a letter") or a *present* tense auxiliary in combination with a participle, i.e., the present perfect (e.g., "he has written a letter").

Aims: The goal of this study is twofold. First, it aims to untangle tense problems from problems with past time reference through verb morphology in people with aphasia. Second, this study aims to compare the production of time reference inflection by people with agrammatic and fluent aphasia.

Methods & Procedures: A sentence completion task was used to elicit reference to the non-past and past in Dutch. Reference to the past was tested through (1) a simple verb in past tense and (2) a verb complex with an auxiliary in present tense + participle (the present perfect). Reference to the non-past was tested through a simple verb in present tense. Fourteen agrammatic aphasic speakers, sixteen fluent aphasic speakers and twenty non-brain-damaged speakers (NBDs) took part in this study. Data were analyzed quantitatively and qualitatively.

Outcomes & Results: NBDs scored at ceiling and significantly higher than the aphasic participants. Agrammatic speakers performed worse than fluent speakers, but the pattern of performance in both aphasic groups was similar. Reference to the past through past tense and [present tense auxiliary + participle] was more impaired than reference to the non-past. An error analysis revealed differences between the two groups.

Conclusions: People with agrammatic and fluent aphasia experience problems with expressing reference to the past through verb inflection. This past time reference deficit is irrespective of the tense employed. The error patterns between the two groups reveal different underlying problems.

Keywords: agrammatic aphasia, fluent aphasia, time reference, tense

INTRODUCTION

Verb inflection is notoriously difficult for individuals with agrammatic speech. Spontaneous speech analysis as well as experimental testing has demonstrated that finite verb forms (those forms that correspond in number and person with the subject of the sentence) are difficult to produce for them (Burchert, Swoboda-Moll, & De Bleser, 2005; Clahsen & Ali, 2009; Friedmann & Grodzinsky, 1997; Gavarró & Martínez-Ferreiro, 2007; Kok, Kolk, & Haverkort, 2006; Kok, van Doorn, Kolk, 2007; Wenzlaff & Clahsen, 2004, 2005; Wieczorek, Huber, & Darkow, 2011). Even though many reasons for this phenomenon have been proposed, most researchers

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agree that tense and aspect, the inflectional forms that are used to set the time frame of the event, are difficult to produce (e.g., Clahsen & Ali, 2009; Friedmann & Grodzinsky, 1997; Gavarró & Martínez-Ferreiro, 2007; Kok, Kolk, & Haverkort, 2006; Kok, van Doorn, Kolk, 2007; Wenzlaff & Clahsen, 2004, 2005; Wieczorek, Huber, & Darkow, 2011), although in some studies agreement has found to be equally, or more impaired (e.g., Burchert, Swoboda-Moll, & De Bleser, 2005; Lee, Milman, & Thompson, 2008). This raises several questions. The first is: why is it so difficult to inflect a verb for tense and aspect and not for agreement? Another question is: are these tense and aspect problems restricted to agrammatic speakers or do all aphasic speakers encounter problems with these grammatical morphemes? In order to answer these questions, one should investigate aphasic verb production in a large variety of languages, since different languages employ different ways to express the time frame of an event through grammatical morphology. The current study addresses two questions on time reference: (1) Do aphasic speakers have a past time reference deficit, irrespective of tense? And (2) are the performance and error patterns of agrammatic and fluent speaking aphasic individuals on time reference comparable? Before reviewing the literature on this topic in aphasia, we will first describe the linguistic background of time reference.

Linguistic background

Tense is a *morphological* inflection that makes a verb finite, whereas **time reference** is a *semantic* feature of the event being described by the verb phrase as a whole. **Tense** provides information about the temporal relation, such as 'simultaneity' or 'precedence,' between the time interval of the event expressed through the verb morphology and the time of evaluation set by the context. **Aspect** further specifies temporal relations by defining the boundaries (beginning, end point) of a situation, telling whether the event is completed or ongoing. It is the combination of tense, aspect, and context that specifies the time reference, as illustrated below.

In Dutch, like in English, both simple verb forms (finite; with tense and aspect expressed on a single lexical verb) and periphrastic verb forms (consisting of a finite auxiliary plus a lexical verb) can be used to refer to the past, see example (1).

(1a) past tense, imperfect aspect

De man	schreef	de brief.	
the man	$\text{wrote}_{\text{past tense}}$	the letter	

The man wrote the letter.

(1b) present tense, perfect aspect

De man	heeft	de brief	geschreven.
the man	$\text{has}_{\text{present tense}}$	the letter	$\text{written}_{\text{past participle}}$

The man has written[1] *the letter.*

[1] The meaning of the Dutch present perfect is closer to the English simple past than to the English present perfect, but to indicate that it is a periphrastic verb form, the literal translation (e.g., "has written") will be used throughout this article. In Dutch, the present perfect is commonly used to refer to

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In example sentence (1a), the verb is inflected for past tense and it refers to the past. In sentence (1b), however, the auxiliary has present tense inflection but the verb complex [have + participle] refers to the past. There is neurophysiological evidence for this distinction between tense and time reference in non-brain-damaged participants, suggesting that it is not only a theoretical distinction: Bos, Dragoy, Stowe and Bastiaanse (2013) found that brain responses to time reference violations by simple and periphrastic verb forms as in (1a-b) are similar, irrespective of the tense used.

Finite Dutch verbs[2] agree in person (in present tense) and number (in present and past tense) with the subject. The third person simple present in Dutch is formed by adding the suffix –/*t*/ to the stem, for example *werk-t:* "work-present/3sg". The simple past is formed by adding the suffix –/*te*/ to the stem, followed by the agreement suffix, for example *werk-te*: "work-past/3sg" The periphrastic past consists of an (irregular) auxiliary (*to have* or *to be*) and the past participle, formed with the prefix *ge-* and the suffix –/*t*/, for example *heeft gewerkt*: "have-present/3sg work-past/participle".

Time reference in aphasia

There are several accounts for the problems with tense inflection in agrammatic aphasia (Burchert, Swoboda-Moll, & De Bleser, 2005; Clahsen & Ali, 2009; Faroqi-Shah & Dickey, 2009; Friedmann & Grodzinsky, 1997; Kok, Kolk, & Haverkort, 2006; Nanousi, Masterson, Druks, & Atkinson, 2006; Wenzlaff & Clahsen, 2004, 2005). However, recently it has been shown that the verb inflection problems are also related to the time frame to which is being referred. More specifically, verb forms that refer to the past are more impaired than verb forms that refer to the non-past,[3] both in production and comprehension (Bastiaanse, 2008; Bastiaanse et al., 2011). Based on an extensive review of aphasiological verb production and comprehension data, Bastiaanse et al. (2011) and Bastiaanse (2013) formulated the PAst DIscourse LInking Hypothesis (PADILIH) to describe the pattern of selective impairment of past time reference and relatively spared non-past time reference. The PADILIH claims that reference to the past through verb forms is discourse linked, regardless of the anaphoric means employed (i.e. not only through tense as suggested by Zagona, 2003). In order to refer to an event in the past, a link has to be made in discourse. The event is then not only processed by narrow syntax, but also by discourse syntax. The scope of narrow syntax is only the sentence; hence, processing at the level of narrow syntax requires less resource capacity and is usually less affected in agrammatic aphasia. Processing discourse syntax requires additional

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the past, unlike in English. Still, the simple past of lexical verbs appears around twice as often as the present perfect in the Spoken Dutch Corpus (2009).

[2] This paragraph is only on regular verbs, since the distinction between regular and irregular verbs is outside the scope of this paper.

[3] Aronson (1977), Partee (1973), and Zagona (2013) suggested that future tense should be seen as a sub-class of present tense, because it is derived from the present tense via modal and aspectual features. This view is adopted here by distinguishing between past and non-past time reference.

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syntactic operations and access to information structure; however, agrammatic individuals lack sufficient resources to apply these operations (Avrutin, 2000; 2006). They fail to perform multiple syntactic operations simultaneously due to limited working memory capacities according to processing accounts such as the one by Caplan, Waters, DeDe, Michaud, and Reddy (2007). Events occurring in the here-and-now of the individual speaking or in the future do not require a discourse link and are, therefore, relatively spared.

During the last couple of years, agrammatic speakers of several languages have been studied to test the PADILIH and the predictions of the PADILIH have been compared with findings from others. The data are summarized below.

Experimental evidence for the PADILIH in agrammatism

There is cross-linguistic evidence supporting and further refining the PADILIH. Yarbay Duman and Bastiaanse (2009) investigated past tense with perfect aspect (e.g., *ütüle-di-m*: "iron-perfect/past-1sg") and future tense with imperfect aspect (e.g., *ütüle-(y)eceğ-im*: "iron-future-1sg") in a sentence completion test in Turkish. In production, Turkish agrammatic speakers experience more problems with a finite verb referring to the past than with a finite verb referring to the non-past. This finding is in line with the proposed distinction between past and non-past.

Bastiaanse et al. (2011) reported data from the Test for Assessing Reference of Time (TART: Bastiaanse, Jonkers, & Thompson, 2008) in languages with a simple verb inflection paradigm (English) and more extensive verb inflection paradigms (Turkish) as well as in a language that uses freestanding grammatical morphemes for time reference (Chinese). The TART is intended for use in many languages and designed for the assessment of time reference expressed by verb forms. It has a production section with sentence-completion (see the "Material and Methods" section) and a comprehension section with picture-sentence matching. The pattern of past time reference being more impaired than non-past time reference emerged in the production and comprehension sections of the TART for English and Turkish. For Chinese, performance in the production section was low overall and in the comprehension section, past time reference was found to be selectively impaired compared to the present and future.

Bastiaanse et al. (2011) also reanalysed the English data of Lee, Milman, and Thompson (2008; Experiment 2) taking into account only tense errors while leaving out agreement errors. The reanalysis showed that simple past tense ('he walked') is more difficult than simple present tense ('he walks') and [auxiliary + past participle] ('he has walked') is more difficult than the present progressive ('he is walking'). This suggests that in both languages, past time reference was impaired in finite and non-finite verb forms. Nanousi et al. (2006) tested Greek agrammatic aphasic participants with a range of tasks. The results of two tasks tapping into tense production were mixed: at sentence level (but not at a single word production task), both the past progressive (e.g., *e-graf-a*: "I was writing") and the simple present were easier than

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the simple past and the periphrastic future.[4] Accuracy on the periphrastic past perfect was somewhere in between. The participants' performances on the periphrastic future are not in line with the PADILIH, but two other tasks did show the predicted pattern: the aphasic participants had more problems with perfect aspect (tested in past perfect) and perfective aspect (tested in simple past) than with imperfect aspect (tested in simple present).

Abuom and Bastiaanse (2013) tested agrammatic Swahili-English bilinguals with the TART (Abuom & Bastiaanse, 2010). They showed that the agrammatic speakers were more impaired in reference to the past than to the non-past in production and comprehension in both languages, and overall more impaired in English than in Swahili. As in Abuom, Obler, and Bastiaanse (2011), they hypothesize that the difference in performance across the two languages is caused by existence of both regular and irregular verb forms in English, since Swahili has a more complex but very regular inflection paradigm.

In multiple-choice sentence completion and grammaticality judgment studies the congruence of the temporal adverb and the verb's tense is manipulated. No clear pattern has emerged from such aphasiological studies. Stavrakaki and Kouvava (2003) reported near-ceiling performance for time reference violations by the past tense. Clahsen and Ali (2009) reported no difference between time reference violations by verbs in past and present tense, and also the grammaticality judgment data from Greek agrammatism by Nanousi et al. (2006) did not yield a particular pattern of time reference errors. Faroqi-Shah and Dickey (2009) tested agrammatic speakers of English' responses to time reference violations. The participants responded faster to violations by a verb with present time reference, than by a verb with past or future time reference, although the accuracy did not differ. These reaction times seem to give more information than grammaticality judgment. However, if errors are made on such a task, it is unclear whether these are due to insufficient processing of the time reference of the verb's tense, of the adverb, or of both. This shows us that multiple-choice sentence completion and grammaticality judgment are suitable to compare between function categories, but not within. Thus, these tests may not be the best tool to investigate time reference processing in an aphasic population.

Spontaneous speech evidence for the PADILIH in agrammatism

Support for the PADILIH has also been found in spontaneous speech. Simonsen and Lind (2002) published a case study on a Norwegian individual with agrammatic Broca's aphasia. In his spontaneous speech with a non-aphasic interlocutor, he did not produce a single verb referring to the past, but relied on strategies such as writing down a year, relying on the interlocutor, or using a noun or adjective to express temporal reference. A verb elicitation task showed that he was able to inflect verbs for reference to the past (although he made errors). The authors conclude that the lack of verb forms with past reference is processing-related, which is in line with Avrutin (200, 2006). Stavrakaki and Kouvava (2003) studied the

[4] In their paper, Nanousi et al. (2006) use the term 'simple future' for periphrastic future.

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spontaneous speech of two agrammatic speakers of Greek.[5] Both aphasic speakers made errors in contexts requiring the perfective past, producing a present time reference form instead. The errors were more likely to occur in syntactically complex contexts, which is in line with a processing account of agrammatism (e.g., Caplan et al., 2007) and of discourse linking in aphasia (Avrutin, 2000; 2006). Beeke, Wilkinson, and Maxim (2003) analysed conversational speech of an English agrammatic speaker (plus spouse) and found that in an obligatory context for past and future time reference, the speaker often produced present time reference or an infinitive.[6] Abuom and Bastiaanse (2012) analysed narrative speech of six agrammatic English-Swahili bilinguals. In both languages, reference to the past was impaired compared to the present; however, in English, errors were mainly tense omissions while in Swahili they were mainly tense substitutions.

In Standard Indonesian, verbs are not inflected for tense and agreement. For time reference, aspectual adverbs are used when the time frame of the event is not clear from discourse. These aspectual adverbs have a similar function as verb inflection for tense and agreement in other languages: they denote whether an event is completed, still ongoing, or has yet to commence. However, these aspectual adverbs are only used when the time frame is not clear from the context. Bastiaanse (2013) argues that these aspectual adverbs are, thus, discourse linked by definition and hence no difference between referring to past, present and future is expected. This is exactly what is reported for Standard Indonesian (Anjarningsih & Bastiaanse, 2011).

Taken together, there is evidence that in agrammatic aphasia, reference to the past is more vulnerable than reference to the non-past in languages with obligatory marking for time reference. Verbs that need discourse linking require more grammatical computation than verbs that are not discourse linked. Also, aspectual markers in Standard Indonesian are vulnerable because they require discourse linking.

As previously stated, there is another unanswered question: whether these time reference problems are specific for agrammatic aphasia. It has been shown that fluent aphasic speakers also have problems with inflected verbs. Therefore, it is conceivable that these problems are also related to time reference.

Time reference in fluent aphasia

One of the issues in aphasiology is to what extent symptoms are specific to a particular syndrome. Bastiaanse (2011), for example, showed that finite verbs in both agrammatic and fluent aphasic spontaneous speech have low lexical variety compared to healthy speech. This difference is not found in non-finite verbs (infinitives and participles).

Relatively few studies investigated time reference in agrammatic and fluent aphasia. Fluent aphasic speakers experience different and less pronounced problems

[5] The authors collected their data in every day conversation that included questions eliciting reference to the past (S. Stavrakaki, personal communication with L.S. Bos, April 24, 2013).

[6] If the future is derived from the present via modal and aspectual features, then this is more demanding than the use of present itself. This may account for the substitution of future with present.

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with tense inflection in spontaneous speech than agrammatic aphasic speakers. However, the finite verbs they use have a higher frequency and a lower diversity than the non-finite verbs, whereas in the spontaneous speech of non-brain-damaged speakers (NBDs) diversity and frequency of finite and non-finite verbs do not differ (Bastiaanse, 2011). Still, in an experimental setting, people with fluent aphasia also show an impaired performance on verbs with past time reference compared to verbs with non-past time reference, which is however qualitatively different from that of agrammatic aphasic speakers (Dragoy & Bastiaanse, 2013; Jonkers & de Bruin, 2009; Kljajevic & Bastiaanse, 2011; Wieczorek, Huber, & Darkow, 2011). Wieczorek, Huber, and Darkow (2011) trained two German speaking individuals with Broca's aphasia and two individuals with Wernicke's aphasia in tense and aspect production. All participants made errors during the baseline task, mainly tense (and therewith aspect) substitutions. The authors did not analyse the errors separately per time frame. They conclude that problems with time reference are not limited to agrammatic Broca's aphasia.

Jonkers and De Bruin (2009) tested simple past and present tense in Dutch. Overall the simple past was more difficult than the simple present for both groups, but fluent aphasic speakers made different errors than agrammatic aphasic speakers. The agrammatic speakers most often made tense substitutions (of simple past and simple present) or used infinitives, while the fluent aphasic speakers mostly made tense errors without a specific pattern (two fluent aphasic speakers mainly made substitutions of past tense with present tense.) However, this study did not focus on a possible difference in error patterns separately per target time frame. Furthermore, only the simple past and present were investigated, not the periphrastic past, so that tense cannot be decoupled from time reference in their results.

A Russian study with the TART included an error analysis targeted at time reference, which showed that the problems with time reference do not surface similarly in agrammatic and fluent aphasic speakers (Dragoy & Bastiaanse, 2013). Accuracy on the time reference conditions showed that past forms were more impaired than non-past forms in both groups. The error analysis revealed that both aphasic groups produced non-past time reference instead of the past target. For target present time reference, substitutions with other non-past time reference verb forms were most frequent. Still, agrammatic speakers were overall less successful in providing the appropriate temporal relations. However, past time reference cannot be teased apart from tense in this Russian study.

All in all, these data suggest that problems with reference to the past through verb inflection are not limited to agrammatic aphasia, but exist in fluent aphasia as well. This does not indicate, however, that the underlying problem in these two aphasia types is the same.

Time reference and theory on speech production

According to Levelt (1989), speech production is a modular process. He distinguishes between grammatical encoding and phonological encoding. Grammatical encoding is the process of sentence construction for which information

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provided by the lemmas of the lexical entries is used. The lemmas activate the lexemes, the underlying phonological word forms that are used for Phonological Encoding. Bastiaanse and Van Zonneveld (2004) used his model to localize the functional deficit in agrammatic aphasia. They argued agrammatic aphasia is a processing deficit and that the production problems are caused by poor grammatical encoding abilities. The more information needs to be encoded, the more prominent the problems will be. It is easy to see how such a deficit can explain the time reference problem in agrammatic aphasia: for reference to the past narrow syntax alone is not enough. It requires discourse linking, an extra grammatical operation, resulting in poor performance.

In fluent aphasia, the major problem is in retrieving the underlying word forms. It is generally assumed that the word forms are available, but difficult to access. Bastiaanse (2011) argued that word retrieval diminishes when more complex grammatical encoding is needed. This interplay between lexical retrieval and grammatical encoding causes, among others, problems with the production of finite verbs in spontaneous speech. These problems will increase when discourse linking is required, thus, in cases of verb forms that refer to the past.

Goals of the study

The goal of the current study is two-fold. First, we aim to investigate whether agrammatic and fluent aphasic speakers have problems with verb forms that refer to the past, irrespective of tense. No previous aphasia study has focused on this specific topic. Dutch is a suitable language to investigate this, because past time reference can be conveyed through verb forms in present tense, as explained above. The current study can thus provide more information on the nature of the time reference deficit. The PADILIH (Bastiaanse et al., 2011, Bastiaanse, 2013) is based on data from agrammatic aphasia and predicts that

(1) agrammatic speakers will perform relatively poor on verb forms that refer to the past, irrespective of the tense of the verb.

This means that both the past imperfect and the present perfect will be more impaired than the present imperfect.

A second goal of the current study is to compare the performance and error patterns of agrammatic and fluent speaking aphasic individuals on time reference, using the same test as Bastiaanse et al. (2011), Abuom and Bastiaanse (2013) and Dragoy and Bastiaanse (2013) did in other languages. Comparing these two groups can illuminate similarities and differences in the origin of problems with verbs that people with agrammatic and fluent aphasia have demonstrated in experiments and in spontaneous speech. Bastiaanse (2011) argued that the poor production of finite verbs in fluent aphasia is caused by the interaction of grammatical encoding and lexical retrieval. For reference to the past, discourse linking is needed. Since discourse linking requires additional grammatical encoding, more errors will be produced when verb forms referring to the past have to be produced. Therefore, it is predicted that

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(2) fluent aphasic speakers will have more problems with verb forms that refer to the past than with verb forms that refer to the non-past.

This means that it is expected that despite the different underlying disorders, the same problems will arise in agrammatic and fluent aphasia. This may show up in different error patterns.

MATERIAL AND METHODS

Participants

The participants of this study were divided into three groups: 20 NBDs, 14 individuals suffering from Broca's aphasia with non-fluent agrammatic speech (B1 to B14) and 16 individuals suffering from fluent aphasia (Wernicke's aphasia or anomic aphasia; F1 to F16).[7] The diagnosis of the aphasic participants was done by the use of the ALLOC scores of the Dutch version of the Aachen Aphasia Test (AAT: Graetz, De Bleser, & Willmes, 1992) or the experimental Dutch version of the Comprehensive Aphasia Test (Swinburn, Porter & Howard, 2004; Dutch version: Visch-Brink, Vandenborre, de Smet, Mariën, in press) and by clinical judgment. The experimenter elicited spontaneous speech using the methods of the AAT. Two independent judges listened to spontaneous speech samples of the participants and classified the speech as either agrammatic (telegraphic, slow speech rate, with omission of grammatical morphemes and function words) or fluent (normal speech rate, with word finding difficulties and occasional (verbal and phonemic) paraphasias and neologisms).[8] The number of words per minute was calculated over 2 minutes of spontaneous speech as an estimate of speech fluency (see Appendix A). The auditory word comprehension test of the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1972; Goodglass, Kaplan, & Baresi, 2001) served as a rough estimate of auditory comprehension (See Appendix A). A further 13 participants were excluded: eight because their non-fluent speech could not be classified as agrammatic, one because the independent judges did not agree on the classification of the speech, and four because they could not do the production test.

All brain-damaged participants were aphasic due to a single left-hemisphere stroke except for F6, who had a right-hemisphere stroke, F8 who had aphasia due to multiple transient ischemic attacks (TIA's), and F11 who had aphasia due to the dissection of a temporoparietal abscess. The lesion of B3 had a small right-hemisphere component. All participants were right-handed except for B12, who was left-handed. Since his performance pattern did not deviate from that of the rest of the group, it was decided to include his data in the analyses on the basis of his language profile.

All participants had normal or corrected to normal vision, and no hearing problems. Dutch was their first language, with or without a regional accent.[9] Mean

[7] None of the participants took part in the study by Bastiaanse (2008) or Jonkers and De Bruin (2009).

[8] The spontaneous speech data will be reported in a separate paper.

[9] B10's first language has been Dutch since age 12, before that she spoke German. F9 was bilingual French-Dutch from early age onwards: He had French parents but grew up in Flanders, where Dutch is the first language.

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age was 55.6 among the agrammatic speakers (range: 39-78) and 59.5 years (range 37-83) among the fluent speakers. In Appendix A, the individual characteristics are given. Twenty NBDs (10 female) were selected to match the aphasic group's characteristics. Their mean age was 54.9 year (range 40-62). As in the two aphasic groups, the educational background varied in level between high school and university. They reported no diagnosed neurological impairment or psychiatric disorder. All participants signed an informed consent according to the Declaration of Helsinki under a procedure approved by the Medical Ethics Committee of the University Medical Center of Groningen (UMCG).

Materials and procedure

The participants were tested with the Dutch version of the production TART (Bastiaanse, Jonkers, & Thompson, 2008). This test has 10 pairs of 2 semantically related transitive verbs, which were both used as target and prompt (i.e., 20 items per condition, see Appendix B). The verb pairs each had the same direct object, for example, *to peel/to eat an apple*. One pair appeared in each of the practice items.[10] Each verb had to be produced once per condition,[11] resulting in 54 experimental items in total (18 items times three conditions).

The three tested conditions were:
Reference to non-past: simple present
→ object plus finite verb in present tense (present tense, imperfect aspect);
(…) *een brief schrijft* (lit. "a letter writes")
Reference to past: simple past
→ object plus finite verb in past tense (past tense, imperfect aspect);
(…) *een brief schreef* (lit. "a letter wrote")
Reference to past: periphrastic past
→ object plus [AUX present tense + participle] (present tense, perfect aspect)
(…) *een brief heeft geschreven* (lit. "a letter has written")

To create an obligatory context for time reference of the verb, a temporal adverb was added to both the probe and the target sentence, which was *nu:* "now" for the simple non-past, *zonet:* "a-moment-ago" for the simple past, and *net:* "just" for the periphrastic past. The verbs were elicited in an embedded sentence, because this

[10] Eleven experimental verbs were regular (weak), and the practice items and seven experimental verbs were irregular (strong). Irregular (strong) verbs usually have a vowel change in the simple past; the participle is formed by the prefix ge-, followed by the stem with vowel change, followed by the suffix –en. The verbs were not controlled for factors such as regularity and frequency, because the pictures of the TART are used in a wide range of languages. The difference between regular and irregular verbs is not in the scope of the current work, but is under debate (e.g., Faroqi-Shah, 2007; Marusch, von der Malsburg, Bastiaanse, & Burchert, 2012; Penke & Westermann, 2006). For the sake of completeness, differential performance on regular and irregular verbs will be mentioned in a footnote.

[11] Two other conditions were tested ([modal + infinitive] and [inchoative + infinitive]). The total number of items on the test was 90. These constructions are irrelevant for the current research questions and are therefore ignored.

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contains the base word order in Dutch. It has repeatedly been shown that for Dutch agrammatic aphasic speakers sentences in the base order are easier to produce than sentences in derived order (Bastiaanse, Hugen, Kos, & van Zonneveld, 2002; Bastiaanse & Thompson, 2003; Bastiaanse & van Zonneveld, 1998).

Two coloured photos above which the corresponding infinitives of the verbs were written accompanied each item. For each verb there were 2 pictures available: one depicting the completed action (past), one with the action being performed (present). In Figure 1 an example of a test item is provided.

Figure 1. Example items for the TART – Production. The Dutch infinitives *lezen:* "to read" and *schrijven:* "to write" are written above the respective pictures. At the top: an example for the condition referring to the present. Below: an example for the conditions referring to the past. For the elicitation procedure, see text.

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The experiment started with a practice trial for each condition with the verb pair *schrijven:* "to write" and *lezen:* "to read". The practice items were repeated until it was clear that the participant understood the task.

Examiner: *Hier zijn twee foto's. Dit is "schrijven" en dit is "lezen". Hier kunt u zeggen "Dit is de man die net een brief heeft geschreven" en hier kunt u zeggen "Dit is de man die net…"*
Here are two pictures. They show the actions "to write" and "to read". For this one (examiner points to the photo on the left), I could say, "This is the man who just has written a letter"; for this picture (examiner points to the target photo on the right) you could say "This is the man who just …"

Participant: *een brief heeft gelezen:* lit."… a letter has read" ("has read a letter")

Participants were tested with the production section of the TART in a single session with a break in the middle of it. Administering the TART took approximately one hour for agrammatic speakers and 40 minutes for fluent speakers. In order to minimize fatigue effects, participants were given a break halfway during a testing session and upon request.

Data analysis

A correct – incorrect scoring system was used. Correct responses included the target time reference inflection on the target lexical verb. Self-corrections were counted as correct. Errors were categorised into one of four main categories: (1) non-past, (2) past, (3) infinitive or (4) uninterpretable time reference. The category non-past had subcategories for (a) periphrastic future (b) simple present; (c) semantic paraphasias [12]; and (d) other non-past constructions. The category 'past' had subcategories for (a) periphrastic past; (b) bare participles; (c) simple past; (d) semantic paraphasias; and (e) other past constructions.[13] The fourth "uninterpretable time reference" category included (a) utterances that were broken off before the lexical verb stem or auxiliary was realised; (b) literal repetitions of the example verb; (c) no responses; and (d) responses without a verb. Omissions or substitutions of the object were not counted as errors.

To test for an overall reliable difference between NBDs and the two aphasic speaker groups, a linear mixed-effects regression analysis was carried out using the *lmer* function of the *lme4* package (Bates, Maechler, & Bolker, 2013) and the *glht* function of the *multcomp* package (Hothorn, Bretz, Westfall, Heiberger, &

[12] Both the categories "non-past" and "past" had the subcategory "semantic paraphasia", which included semantic paraphasias with the target verb inflection. Semantic paraphasias with non-target verb inflection were categorised according to the erroneous inflection, since the primary interest of the current study was time reference.

[13] Other past constructions included regular inflection on irregular verb stem, irregular inflections on regular verb stems, incompletely realised participles containing the lexical stem, and the past perfect.

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Schuetzenmeister, 2013) in R (R Core Team, 2013). The dependant variable of the model was accuracy (1=correct, 0= incorrect) with random effect factors for participants and items. A separate model was developed to investigate differences between conditions and aphasic participant groups. This model contained the fixed effects aphasia type, condition and trial number and random effect factors for participants and items with random slopes for condition per participant. The model was developed by excluding insignificant parameters from a maximal model containing the fixed effects aphasia type, condition, and trial number with interactions between them. Model comparison was based on AIC and log-likelihood ratio tests (significance defined as $p < .05$). Per condition, a time reference error analysis was carried out using chi-square tests with Yates' correction for continuity to investigate the relation between aphasic participant group (agrammatic/fluent) and the main categories of time reference substitutions (non-past/past).

RESULTS

In Figure 2, the mean percentage of correct responses on the TART-production is given for the three groups.[14] The 20 NBDs scored at ceiling. No errors were made on the simple present. Mean score on simple past was 98.9% (range 89-100%). On periphrastic past, the mean was 99.7% (range: 94-100%). The accuracy of the agrammatic and fluent aphasic speakers was significantly lower than the accuracy of the NBDs ($\beta = -6.95$, SE = 0.76, $z = -9.09$ and $\beta = -5.09$, SE = 0.75, $z = -6.75$, respectively). The data of NBDs will be further ignored. The fluent speakers performed overall better at the test than the agrammatic speakers ($\beta = 1.86$, SE = 0.52, $z = 3.58$).

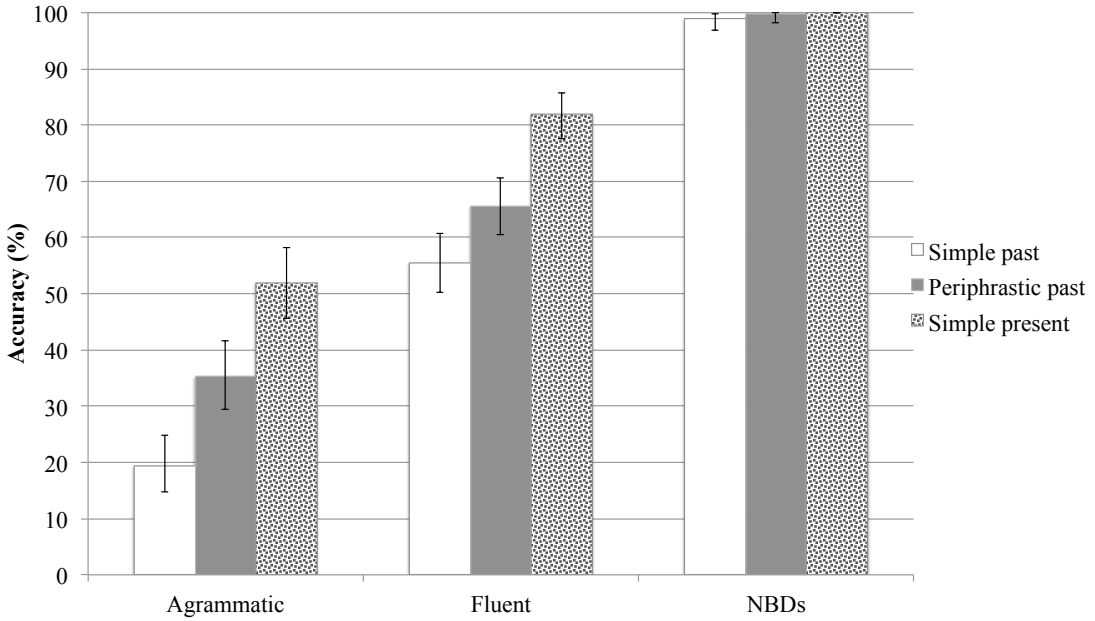

Figure 2. Accuracy on the verb forms per participant group, with the 95% confidence interval.

[14] Adding the object sentence-final (not counted as an error) was done four times by F6, and 41 times by B9, similarly divided over the conditions.

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TABLE 1.

Error types (percentages of the total number of errors) of agrammatic and fluent speakers. In grey shading are the substitution errors that have the targeted time reference.

Target form ➔		*Simple past*		*Periphrastic past*		*Simple present*	
Substitution ➘		*Agrammatic*	*Fluent*	*Agrammatic*	*Fluent*	*Agrammatic*	*Fluent*
Non-past	Periphrastic future	5%	8%	2%	9%	18%	29%
	Simple present	18%	16%	10%	12%	-	-
	Semantic paraphasia	-	-	-	-	2%	8%
	Other non-past	9%	8%	9%	19%	9%	29%
	Total (number)	**32% (65)**	**32% (41)**	**21% (35)**	**40% (40)**	**30% (36)**	**65% (34)**
Past	Periphrastic past	20%	29%	-	-	10%	10%
	Participle	7%	13%	17%	16%	4%	2%
	Simple past	-	-	5%	24%	6%	13%
	Semantic paraphasia	1%	4%	4%	5%	-	-
	Other past	5%	14%	14%	11%	1%	2%
	Total	**33% (68)**	**60% (77)**	**40% (65)**	**57% (56)**	**21% (25)**	**27% (14)**
Infinitive		32%	6%	32%	2%	45%	4%
Uninterpretable time reference		2%	2%	7%	1%	4%	4%
Total number of errors		*203*	*128*	*163*	*99*	*121*	*52*

An overview of the error type percentages in each condition by the two groups of aphasic participants is given in Table 1. Individual accuracy scores are in Appendix C. There were no significant interactions between the factors aphasic participant group and condition (model with versus model without an interaction: χ^2 (2) = .08, p = .96). Overall, the aphasic individuals were less accurate on simple and periphrastic past than on the simple present (β = -2.15, SE = 0.28, z = -7.59 and β = -1.23, SE = 0.40, z = -3.12 respectively). Furthermore, there was a marginally significant difference between the simple past condition and the periphrastic past condition (β = -0.92, SE = 0.40, z = -2.29, p = .06).[15] Agrammatic speakers used an infinitive – which does not carry time reference information – for 32% of the errors on both the past conditions and 45% of the errors on the present time reference condition.

Analysis of the errors' time reference in the simple present condition shows that the errors had the targeted non-past time reference (χ^2 (1, N = 109) = 1.16, p = .28). The error patterns of the two aphasic groups differ in the simple past condition, the most difficult condition for both groups. In this condition, 33% of the errors of agrammatic speakers has past reference, compared to 60% of the errors of fluent aphasic speakers (χ^2 (1, N = 251) = 4.55, p < .05). For agrammatic speakers, substitutions of the simple past by the periphrastic past form occurred as often as substitutions by the simple present (20% and 18%, respectively). Fluent aphasic speakers substituted the simple past by the periphrastic past most frequently, in 29% of the errors. Past participles without an auxiliary and the simple present were also produced.

In the periphrastic past condition, the pattern of time reference substitutions by the two aphasic participant groups did not differ (χ^2 (1, N = 196) = 0.66, p = .42). For agrammatic speakers, errors most often constituted omissions of the tensed auxiliary (resulting in a bare participle). Agrammatic speakers applied the correct past time reference for less than half of the errors, whereas fluent aphasic speakers maintained

[15] Accuracy on regular and irregular verbs, respectively for agrammatic speakers: 7%-27% on simple past; 27%-41% on periphrastic past: 54%-51%, on simple present. For fluent aphasic speakers: 46%-62% on simple past; 71%-63% on periphrastic past; 83%-81% on simple present.

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past time reference for the majority of the errors. Most of the errors on periphrastic past by fluent aphasic speakers were substitutions by simple past or a bare participle.

DISCUSSION

The current study aimed at investigating whether the problems with verbs referring to the past that aphasic individuals experience are restricted to the past tense or extend to past time reference in general. Second, it further investigated differences in the nature of the past time reference deficit between agrammatic and fluent aphasic speakers.

Past time reference deficit irrespective of tense in agrammatic aphasia

The first prediction, that in agrammatic aphasia reference to the past is impaired irrespective of the finite verb's tense, is supported by the data: Past time reference through both the simple and periphrastic past is more impaired in Dutch agrammatic speakers than the simple present. This is in line with findings from previous studies in other languages (Abuom & Bastiaanse, 2012, 2013; Abuom, Obler & Bastiaanse, 2011; Bastiaanse, 2008; Bastiaanse et al., 2011; Dragoy and Bastiaanse, 2013, Faroqi-Shah & Dickey, 2009; Jonkers & de Bruin, 2009; Lee, Milman & Thompson, 2008; Nanousi et al., 2006; Simonsen & Lind, 2002; Stavrakaki & Kouvava, 2003; Wieczorek, Huber, & Darkow, 2011; Yarbay Duman & Bastiaanse, 2009) but some studies do not show a difference between past and non-past (Burchert et al., 2005; Clahsen & Ali, 2009; Kok et al., 2007; grammaticality judgment in Nanousi et al., 2006; Wenzlaff & Clahsen, 2004). The results provide further support for the PADILIH (Bastiaanse et al., 2011) that says that in order to produce a verb form that refers to the past, a link has to be made in discourse, for which discourse syntax is needed. This process is, however, compromised in agrammatic aphasia (Avrutin, 2000, 2006). The PADILIH does not apply to tense, but to the time reference of the verb form as a whole. Time reference assignment to a verb is an interaction between tense, aspect and context. The deficit is, thus, independent of whether the past time reference is expressed through past or present tense: The periphrastic past form, with an auxiliary in present tense, was also impaired compared to the simple present.[16]

Time reference in agrammatic and fluent aphasia

The second prediction was that fluent aphasic speakers also encounter more problems with verb forms referring to the past than with verbs referring to the non-past, even though they suffer from a different underlying deficit. The data also supported this hypothesis. However, the agrammatic speakers were overall less accurate than the fluent aphasic speakers. Of course, the overall degree of the time reference difficulties may have been influenced by the severity of aphasia in the two

[16] However the simple past appears around twice as often as the present perfect in the Spoken Dutch Corpus (2009), agrammatic speakers may sometimes exhibit a preference for verb forms that have a lower frequency of occurrence than other verb forms (Bastiaanse, Bouma, & Post, 2009)

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groups. The Dutch agrammatic speakers perform more poorly in the present tense condition than the English (78% correct) and Turkish (72% correct) agrammatic speakers of Bastiaanse et al. (2011), although the test was the same. What is important, however, is that the pattern of impairment is the same in agrammatic and fluent aphasia: There was no interaction between the factor of aphasia type and the factor of condition (see also Figure 1). For the aphasic individuals overall, time reference to the past was more impaired than time reference to the present. Also in the healthy language system, discourse-related differences between non-past and past time reference exist (Dragoy, Stowe, Bos, & Bastiaanse, 2012) which are irrespective of tense, as shown in neurophysiological responses to time reference violations (Bos et al., 2013).

The production accuracies on the simple present condition were not at ceiling, either. The PADILIH does not suggest that that tense as such is unaffected in aphasia, but that past time reference is particularly difficult compared to non-past time reference. Other studies have addressed a general difficulty with tense in agrammatism (e.g., Burchert, Swoboda-Moll, & De Bleser, 2005; Clahsen & Ali, 2009; Faroqi-Shah & Dickey, 2009; Friedmann & Grodzinsky, 1997; Kok, Kolk, & Haverkort, 2006; Nanousi et al., 2006; Wenzlaff & Clahsen, 2004, 2005).

The difference between agrammatic and fluent aphasia becomes apparent by an error analysis. Both groups made errors in all conditions, but in the two past conditions, fluent aphasic speakers' errors generally referred to the past, while the majority of agrammatic speakers' errors did not. In the most difficult condition, the simple past, fluent aphasic speakers frequently used the periphrastic past. In the majority of cases, agrammatic speakers produced verb forms without past time reference (infinitives and simple present forms), but if they remained in the correct time frame, they preferred the use of periphrastic past to the use of simple past as well.

The results are in line with the data of the Russian agrammatic speakers tested by Dragoy and Bastiaanse (2013). The agrammatic speakers assigned temporal relations in a less consistent way than the fluent aphasic speakers. Agrammatic speakers of both Dutch and Russian produced more infinitives and other forms without time reference than the fluent aphasic speakers did. However, in Russian, not only agrammatic, but also fluent aphasic speakers changed the target past time reference to non-past time reference in most cases. This difference is probably related to structural differences between the two languages. Aspect in Russian is lexicalized, meaning that perfect and imperfect verbs are separate lexical entries. When making errors, the Russian aphasic speakers usually retained the target aspect and, therewith, the target lexical verb, but consequently not the target time reference. In Dutch, aspect is less prominent and fluent aphasic speakers generally produced errors with the target past time reference.

Same patterns, different underlying disorders

Discourse linking poses difficulties for both fluent and agrammatic aphasic speakers, but the underlying disorder is different in these two groups. Agrammatic speakers have problems with grammatical encoding. The more grammatical encoding

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is required, that is, the more grammatical operations are needed, the more problems arise for agrammatic individuals (see, e.g., Bastiaanse & van Zonneveld, 2004). Reference to the past requires discourse linking (Zagona, 2003) and discourse linking requires additional resources at the level of grammatical encoding (Avrutin, 2000; 2006). Agrammatic speakers avoid this discourse linked processing by not referring to the past: The majority of their errors are non-past verb forms. Fluent aphasic speakers have problems with lexical retrieval. If more resources are needed for grammatical encoding — which is the case when discourse syntax is required — lexical retrieval will diminish. As a result, they experience difficulties in retrieving the correct lexical form. Discourse linking requires extra grammatical encoding. Since neither of these processes as such is impaired, the verb forms that are produced are still in the correct time frame. However, the correct verb form is no longer retrieved when additionally extra grammatical encoding is needed: Simple and periphrastic forms are replaced by each other.

In conclusion, agrammatic and fluent aphasic speakers suffer from different underlying deficits. However, complex grammatical operations influence performance in both aphasia types. The current study focused on time reference and showed that reference to the past through verb inflection is more difficult than reference to the non-past for both aphasia types. This is explained by the need of discourse linking in case of verb forms referring to the past. When grammatical encoding is affected, as is the case in agrammatic aphasia, problems with discourse linking arise and verb forms referring to the past are being replaced by verb forms referring to the non-past. When lexical retrieval is impaired, extra grammatical encoding, as needed for discourse linking, diminishes lexical retrieval and verbs forms referring to the past are confused.

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APPENDIX A. Individual aphasic participant data

	Age	Sex	Hand	(Former) profession	Speech rate w/m	Aetiology	Time PO	BDAE
Agrammatic speakers								
B1	50	F	R	Cleaning lady, housewife	22	iCVA left	8 m	72
B2	56	M	R	Software designer	37	iCVA left ACM	7 m	72
B3	42	F	R	Office employee	27	iCVA left frontoparietal and smaller right parietal	3 y 4 m	68
B4	49	F	R	Elderly caretaker	42	iCVA left	5 y 4 m	71
B5	76	M	R	Architect	70	iCVA left ACM	4 y	66.5
B6	56	F	R	Canteen manager	87	iCVA left ACM	3 y 6 m	64
B7	49	M	R	Mechanical engineer	46	iCVA left with hemorrhagic component	5 y 9 m	66
B8	58	M	R	History teacher	40	iCVA left ACM and capsula interna	5 y 6 m	65.5
B9	40	F	R	Bookkeeper	29	iCVA left ACM	4 y	69
B10	56	M	R	Logistic manager	68	iCVA left ACM	4 y 6 m	64
B11	78	M	R	Technical manager	56	iCVA left ACM	15 y	72
B12	63	M	L	Constructional calculator	51	iCVA left	1 y	72
B13	67	F	R	Guesthouse owner	20	iCVA left frontoparietal ACM	6 m	60
B14	39	M	R	Carpenter historic buildings	34	iCVA left ACM	1 y 2 m	72
Fluent speakers								
F1	41	M	R	Construction worker	111	iCVA left	4 m	72
F2	66	M	R	Navy officer	119	iCVA left ACM	10 m	61
F3	57	M	R	Administrative assistant	135	CVA subcortical left	5 m	72
F4	59	M	R	Teacher polytechnic	161	CVA left temporal	4 m	72
F5	80	F	R	Housekeeper	117	CVA left	6 m	72
F6	71	M	R	Director building agency	141	iCVA right	11 y	72
F7	62	F	R	Office employee in factory	140	hCVA during resection meningioma left frontal, post-operative bifrontal (more left) iCVA	1 y 4 m	72
F8	45	M	R	Electrician	161	TIA's after dissection carotis interna left	1 y 9 m	72
F9	46	M	R	Military policeman	100	iCVA left	9 m	69.5
F10	41	F	R	Communication specialist	147	iCVA left temporal	6 y	70
F11	63	F	R	Tourist guide	207	Dissection abscess left temporoparietal	3 y	72
F12	65	M	R	Project leader in electricity	150	iCVA left temporofrontoparietal	1 y 6 m	72
F13	53	M	R	Teacher polytechnic	122	hCVA left frontotemporal	9 m	72
F14	83	M	R	Construction worker	149	iCVA left temporoparietal	5 y	71
F15	37	F	R	Financial administrator	106	iCVA left	2 y 2 m	72
F16	83	M	R	General director	102	iCVA left	2 y 3 m	69

Appendix B. Verb pairs with corresponding nouns used in the test items.

Verb		**Noun**	
Practice items			
lezen	*to read*	brief	*letter*
schrijven	*to write*	brief	*letter*
Experimental items			
drinken	*to drink*	melk	*milk*
inschenken	*to poor*	melk	*milk*
plakken	*to paste*	papiertje	*paper*
scheuren	*to tear*	papiertje	*paper*
tekenen	*to draw*	vierkant	*square*
schilderen	*to paint*	vierkant	*square*
strijken	*to iron*	trui	*sweater*
vouwen	*to fold*	trui	*sweater*
slijpen	*to sharpen*	potlood	*pencil*
breken	*to break*	potlood	*pencil*
naaien	*to sew*	lapje	*cloth*
breien	*to knit*	lapje	*cloth*
schillen	*to peel*	appel	*apple*
eten	*to eat*	appel	*apple*
trekken	*to pull*	kar	*cart*
duwen	*to push*	kar	*cart*
vullen	*to fill*	doos	*box*
legen	*to empty*	doos	*box*

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Appendix C. Individual accuracy scores, calculated over 18 items per condition.

	Simple past	Periphrastic past	Simple present
Agrammatic speakers			
B1	44%	6%	78%
B2	50%	50%	72%
B3	50%	83%	89%
B4	0%	61%	11%
B5	33%	0%	78%
B6	0%	0%	11%
B7	0%	6%	17%
B8	17%	50%	28%
B9	6%	28%	56%
B10	11%	0%	72%
B11	6%	11%	39%
B12	28%	94%	94%
B13	0%	22%	33%
B14	28%	83%	50%
Mean	**19%**	**35%**	**52%**
Fluent speakers			
F1	61%	39%	67%
F2	0%	6%	33%
F3	89%	94%	94%
F4	83%	100%	100%
F5	0%	44%	28%
F6	44%	17%	83%
F7	89%	89%	100%
F8	83%	94%	100%
F9	50%	72%	56%
F10	56%	94%	100%
F11	100%	89%	100%
F12	17%	83%	94%
F13	89%	100%	100%
F14	0%	6%	89%
F15	94%	72%	100%
F16	33%	50%	67%
Mean	**56%**	**66%**	**82%**

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